**Kinematics** = study of motion along a straight-line path. The relationship between distance, velocity, and acceleration is displayed below.

a =

v =

Distance (s) Velocity (v) Acceleration (a)

s =

v =

**Conventions**

Several conventions hold in kinematics problems.

1) **Initial values** apply when time is 0, i.e. when motion started.

2) **Zero values**

a) Distance = 0 means object is at the **origin**

b) Velocity = 0 means the object is **stationary**.

c) Acceleration = 0 means the object is travelling at **constant speed**.

3) **Positive values**

a) Distance > 0 means object is **above** or to the **right** of the origin.

b) Velocity > 0 means object is travelling **forwards** or **upwards**.

c) Acceleration > 0 means object is **speeding up**.

4) **Negative values**

a) Distance < 0 means object is **below** or to the **left** of the origin.

b) Velocity < 0 means object is travelling **backwards** or **downwards**.

c) Acceleration < 0 means object is **slowing down**.

5) gives the distance travelled in between and seconds.

**Examples**

1. A stone is thrown vertically upwards into the air. Its height in metres above the ground is

given by s(t) = 30t – 5t2 .

a) Calculate the initial velocity

b) Calculate the maximum height reached by the object

c) When does the object return to the ground?

*a) initial velocity = v(0)*

*b) max height is when it stops travelling upwards and starts to fall down, and this is where it’s velocity is 0, i.e. solve v(t) = 0*

*c) when it’s distance from the ground is 0, so solve s(t) = 0.*

2. The velocity (in m/s) of an object *t* seconds after it started from the origin is given by

v(t) = 3t2 – 14t – 5. The object is travelling in a straight line in an East-West direction.

a) Give the formulae for the acceleration and distance after *t* seconds.

b) Calculate the initial velocity. In which direction is the object moving?

c) When is the object at rest?

d) Calculate the minimum velocity. Interpret this answer.

e) How far did the object travel in the eighth second?

a) a = dv/dt s = = t3 – 7t2 – 5t + c

Object started from origin, so s = 0 when t = 0, giving c = 0.

b) find v(0)

c) Object is at rest when v = 0, so solve v(t) = 0.

d) Minimum velocity when its derivative is 0 i.e. when a(t) = 0, so solve a(t) = 0.

e) Distance travelled in eight second

= difference between distance of object from origin after 7 seconds and after 8 seconds

= s(8) – s(7)

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